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## **Energy renovation practices in Danish homes: The influence of energy labels on home renovation practices**

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### **Abstract**

Heating of dwellings represents a major policy challenge for the transition to a low carbon society. In Denmark, heating of dwellings represents about 25% of the total Danish final energy consumption and about 13% of the total CO<sub>2</sub> emission. The majority of this is related to heating of older dwellings, and as the rate of replacement is low, the main potential for energy saving is to improve the energy efficiency of the existing dwelling stock through energy renovation.

This paper provides an analysis of Danish experiences with energy labels (also known as the Energy Performance Certificate, EPC), which indicate the energy efficiency of buildings and include recommendations for improvements. The aim of the EPC is to motivate homeowners to do energy improvements. In Denmark, energy audit schemes dates back to the early 1980s and energy rating of houses (energy labelling) was introduced in 1997. The long history of energy audit schemes and energy labelling makes Denmark an interesting case for the study of the experiences with and impact of this kind of policy measure. With the EU Energy Performance of Buildings Directive (EPBD) from 2002, an energy labelling scheme similar to the Danish scheme introduced in 1997 is now in use in all EU member states.

The focus of this paper is on the homeowners' experience and use of the EPC and the key research questions are: How do the homeowners understand and use the EPC? Does the EPC have an influence on home energy renovation practices? The analysis is based on results from a survey of Danish homeowners who have

purchased a home with an EPC within recent years. The Danish survey is part of the European project IDEAL EPBD, which was funded by the European Commission under the Intelligent Energy Europe programme and run from 2008 to 2011. The results indicate a rather limited influence of the EPC on Danish homeowners' home energy renovation practices. Also, the results show that even though most homeowners find the label both reliable and easy to understand, less than 40% find it useful as a source of information on how to improve the energy efficiency of their home.

## **1. Introduction**

The energy consumption of the household sector represents a major policy challenge for the transition to a low carbon society. In Denmark, heating of dwellings makes up 25% of the total Danish final energy consumption and about 13% of the total CO<sub>2</sub> emissions (Statistics Denmark 2010). Similar figures can be found in most other European countries: In 2009, the households' final energy consumption (incl. electricity) represented 27% of the final energy consumption at the EU-27 level (Eurostat 2011). It is estimated that about 70% of this is related to heating (Odyssee/MURE 2009). Thus, about 19% of the final energy consumption in EU-27 is related to heating households.

Like in other countries, the majority of the Danish household energy consumption for heating is related to older dwellings (Wittchen 2004), and as the rate of replacement is low, the main potential for energy saving is to improve the energy efficiency of the existing dwelling stock through energy renovation. Research have documented that 30-35% of the energy used for heating in Danish buildings could be saved by making renovations with a reasonable payback time (Wittchen 2009).

Since the 1990s, energy inspections and energy labelling have played a key role in Danish energy policy aimed at reducing the energy consumption for heating in existing dwellings. The energy inspection scheme actually dates back to the early 1980s, but the first scheme (called the "Heating audit scheme") had a limited effect and coverage, and it was replaced by a new scheme in 1997 called the "Energy labelling scheme for small buildings". Besides a description of the energy efficiency of the home and recommendations for improvements, the scheme now also included an energy label, which showed the level of energy efficiency of the house compared with other buildings. The energy labelling scheme was revised in 2006 in order to make it comply with the EU Directive 2002/91 on the Energy Performance of Buildings (EPBD), which partly builds on the ideas and early experiences with the Danish energy labelling scheme from 1997.

An energy performance certificate (EPC), including the energy label, has to be issued by an authorized energy auditor for all houses put up for sale as well as for new buildings. The energy label places the house on a scale from A1 to G on the basis of the calculated energy consumption with A1 being the most efficient and G the least (B corresponds to the energy requirements in the building codes). Besides the label, the EPC also includes recommendations for improvements of the energy efficiency of the house. These are divided into "profitable improvements" (with a payback time less than the expected life time of the improvements) and "other improvements", which are recommended to be carried out in relation to other larger home improvements. The recommendations include estimates of necessary investments, annual savings from improvements (in DKK and energy units) and the estimated payback time for the investments.

The long history of Danish energy audit schemes and energy labelling makes Denmark an interesting case for the study of the experiences with and impact of energy labelling. Furthermore, with the EPBD directive, an energy labelling scheme very similar to the scheme that has been in place in Denmark since 1997 is now mandatory for all EU member states. It is therefore of special interest to analyse the Danish experiences in order to inform policy making in Denmark as well as in EU in general.

Previous studies of the efficiency and impact of energy labelling schemes are few (see e.g. Gram-Hanssen et al. 2007; Gruber et al. 2005). With regard to the Danish scheme there have only been two evaluations of the scheme in force from 1997, and both are quite critical with regard to the efficiency of it. The first was carried out in 2000 (Madsen et al. 2001), and it concluded that the scheme had a limited coverage (only 50-60% of the buildings subject to an energy audit had been labelled) and survey data showed no significant difference with regard to energy and water saving activities between homeowners with an energy label versus those without. The limited effect of the EPC was later confirmed by a quantitative study, which compared the development over time in actual energy consumption for heating between labelled and non-labelled single-family houses sold in 1999-2002 (Kjærbye 2008). Based on a statistical analysis of the actual consumption, register data on the houses and data from the energy labelling database, this evaluation found no significant energy savings due to the energy labelling scheme for small buildings.

Thus, previous evaluations of the Danish energy labelling scheme have been quite disappointing. However, there has not been a thorough evaluation of the efficiency of the scheme since the latest major revision in 2006. Estimates done by the authors indicate that the EPC still has a relatively limited coverage as only about 60% of the new-built houses or houses marketed for sale during 2007-08 had an energy label (Gram-Hanssen & Christensen 2010). On the other hand, a number of revisions of the scheme have recently been decided that might help increase the general awareness of the EPC. In the summer of 2010, it was made mandatory that the energy label not only should be included in the estate agent's sales material but also in advertisements in newspapers etc. Thus, the label has become much more visible to the public and to potential house buyers. Also, in 2011 the public access to all EPC's have been improved by including these on the website [www.boligejer.dk](http://www.boligejer.dk) where one can find a wide range of information about every house in Denmark, including the EPC, by searching on the address. This reflects an increased focus of the Danish energy authorities on making the EPC into a source of information to be used not only by homebuyers and homeowners but also the different types of actors around the household, e.g. municipalities, tradespeople and bank advisers. The idea is that actors who are in contact with the household on other issues than energy renovations can easily include knowledge from the label in their advice and dialogue with the household.

This paper provides an analysis of Danish experiences with the energy labelling scheme for small buildings. Focus is on the homeowners' experience and use of the EPC and the key research questions are: How do the homeowners understand and use the EPC? Does the EPC have an influence on home energy renovation practices? The analysis is based on results from a survey of Danish homeowners who have bought a home with an EPC within recent years. The Danish survey is part of the European project "Improving Dwellings by Enhancing Actions on Labelling for the Energy Performance of Buildings Directive" (IDEAL EPBD), which was funded by the European Commission under the Intelligent Energy Europe programme and run from 2008 to 2011.

The next section presents a brief literature review of previous studies on home energy renovation and the different factors that influence homeowners' energy renovation practices. A section on the methods follows before the results are presented. The paper ends with a concluding discussion of the results and some general policy recommendations for the future development of the energy labelling scheme with relevance not only for Denmark but also for the European policy making in general.

## **2. Previous research**

A literature review carried out as part of the IDEAL-EPBD project (see also Brohmann et al. 2009; de Best-Waldhober et al. 2010) shows that several research disciplines have studied consumers' reactions to energy and energy performance, although only few have addressed the effect of energy labelling specifically. The

different theoretical perspectives and methodological approaches of each discipline make it impossible to synthesise the results into one single theory or model. However, the results help to illuminate different aspects of energy renovation practices and show that homeowners' decision-making with regard to doing energy renovation is influenced by a wide range of different and often intertwined considerations and factors related to the interests and motivations of the homeowner as well as the context of the home. Rather than making a detailed summary of each of these different approaches, we will briefly summarise the main factors identified by the different studies, which we will group in five tentative categories: financial issues, social context and lifestyle, information issues, the decision-making context, environmental awareness and life events and routines.

*Financial issues:* The influence of financial issues on homeowners' decisions in relation to energy renovation is the research area that has been most developed within the literature on home energy renovation. Several studies focus on the effect of different types of economic incentives such as greater use of pricing measures to encourage environment-friendly behaviour (e.g. Poterba 1991; Smith 1992; Cornwell & Creedy 1996). Many studies of the role of private-economic financial outcomes show that people do not make consistently economically rational decisions (e.g. Camerer & Loewenstein 2004). This challenges the widespread assumption among many policy makers (and researchers like mainstream economists as well) that individuals tend to act as rational and utility maximizing actors with a particular focus on maximizing the cost-effectiveness and profitability of different alternatives. The literature identifies different reasons for individuals not being "economical rational actors"; for instance, time can be an issue in the sense that long payback time hinders energy efficiency investments (Sunikka 2005).

*Social context and lifestyle:* Some authors point at the influence of the social network such as friends, family, colleagues, neighbours and peers on people's perceptions, opinions and behaviours (Bruppacher & Ulli-Beer 2001). This includes the importance of social status and symbolical communication. For instance, it is proposed that homeowners are most likely to realize energy savings if these are both visible and contribute positively to one's symbolical communication with others (e.g. Jensen 2004). Another strand of sociological theories relates to lifestyle and everyday life studies. These studies move the focus from the energy saving activities in themselves and place these within the broader context of lifestyles and everyday life, which they form part of. For instance, Darby (2006) emphasises that carrying out energy efficiency measures is embedded in how the family relates to home improvements in general and, because of this, to considerations of comfort, fashion and convenience. Other studies focus on how people's practices are influenced by different elements such as the technological infrastructure (e.g. the energy saving products available on the market and their material characteristics) and cultural understandings (e.g. Wilhite et al. 1996; Shove 2003).

*Information issues:* The way information on energy saving solutions is presented and communicated, as well as the context the information is presented within, can play an important role for whether the information influences homeowners' energy saving practices. Uitdenboger (2007) detects knowledge about choices and costs as strongest internal determinants of behaviour and the possibility of choice as the strongest external determinant. She qualifies comparative feedback, tailored advice and incentives at the most effective instruments. Also, the level of trust in the (motivation of the) source of information plays an important role for whether information leads to changes in practice (Bartiaux 2003).

*Decision-making context:* The context of situations of decision-making is important in itself. The literature points at different context-related situations that can influence decision-making such as the principal agent problem, which denotes a situation where the person who can make a decision on for instance investments in energy renovation is not the same as the person who will benefit from this decision, e.g. a landlord versus the

tenants who cover the running costs for energy but are not able to make decisions on home improvements (Gelissen 2008).

*Environmental awareness:* The relation between the awareness (or perception) of environmental issues is often discussed as an influential factor for attitudes and behaviour towards energy saving activities. Herring (2007) suggests that individuals' environment-related attitudes have an impact on whether they adopt energy efficiency measures and also points at the influence of people's socio-economic background.

*Life events and routines:* Several studies suggest that there are different periods in the life of people where they are more sensible to making changes in their daily routines. One example of this kind of "windows of opportunities" is the time when homeowners' buy a new dwelling. Also, some authors note how the needed changes in everyday routines and the work and mess associated with home energy renovation have a negative influence on homeowners' willingness to carry out such renovations (e.g. Gelissen 2008).

These different fields of research and contributions to the understanding of homeowners' energy renovation practices forms the theoretical context for the discussion of the survey results presented in this paper.

### **3. Method**

The results presented in this paper are based on a cross-national survey carried out in relation to the IDEAL EPBD project, which focuses on understanding households' home renovation energy efficiency behaviour and includes both qualitative and quantitative studies for ten EU member states. The cross-national survey was carried out in five countries (England, Germany, Finland, the Netherlands and Denmark) and its objective was to report on the behaviour and attitude of homeowners towards the Energy Performance Certificate (EPC). The main aims were to provide an overview of the energy renovation behaviour of homeowners, to measure the use and effectiveness of the EPC and to make a cross-national comparison of homeowners' attitude and behaviour to energy efficiency renovation of their home. As the focus of this paper is on the Danish experiences with the EPC, we will only include the Danish results and not the comparison between countries.

The development of the questionnaire was informed by the previously mentioned literature review carried out as part of the project (Brohmann et al. 2009), stakeholder interviews, national policy reviews and the results from 50 in-depth pilot interviews. The objective of the survey was to provide an overview of the of homeowners in relation to home energy renovation, measure the use and effectiveness of the EPC and compare the homeowners' attitude and behaviour to home energy renovation by country. Besides general questions about the homeowner and his/her home (e.g. age of the respondent, his/her occupational status, number of household members, the time of home purchase etc.), the questionnaire included questions on the homeowner's:

- attitude to home buying (e.g. reasons for the purchase of his/her current home)
- experience of current dwelling (e.g. the condition of the dwelling and the level of experienced comfort)
- previous and planned home improvements and the reasons for doing these (including energy-related improvements)
- awareness and knowledge about the EPC (e.g. if the respondent remembered if his/her house had an EPC)
- experience and use of the EPC (e.g. whether the EPC had influenced the homeowner's decision to buy his/her current home)
- general awareness and interest in environment-friendly behaviour

Before finalizing the questionnaire, a qualitative pilot was carried out with the participation of 13 UK homeowners recruited by mail from a database of recent home buyers.

In total, more than 3,000 homeowners completed the online survey for the five countries. The target group was homeowners living in detached, semi-detached or terraced houses who had recently bought a property (within 6-24 months of the survey) with an EPC. In Denmark, a sample of 10,000 addresses was drawn randomly from a database containing the 65,937 dwellings that had been issued an energy label during the period January 2008 to September 2009. Response were received from 757 individuals (8% response rate), 743 were homeowners and therefore included in the statistical analysis. The sample was approached by mail. The letter explained that the survey was about homeowners comfort and did not specifically mention that the EPC or behaviour related to home energy renovation were its focus. The invitation included a link to the questionnaire and unique identifier, which was used to ensure that only homeowners from the database completed the online survey. The letters were mailed in the middle of June 2010 and responses were received from the mid-June to mid-August 2010. The results of the statistical analysis of all five countries and further details on the method can be found in Adjei et al. 2011.

## **4. Results**

This section begins with a presentation of the main characteristics of the Danish sample, including a few remarks on the question of representativeness. Then follows results describing the homeowners' renovation practices in general, motivations for doing home improvements and trust in different sources of information. The aim of this is to provide a context for the interpretation of the specific results related to the homeowners understanding and use of the EPC, which are presented in the last part of this section.

### **4.1 The Danish sample**

The Danish sample has a small overrepresentation of men as 60% of the respondents are men and only 40% woman. The mean age of respondents is 44.3 years. In terms of age distribution, no respondents are younger than 21 years while 16% are older than 60 years. Most are in their thirties (32% are aged 31-40 years) and the second largest group were in their forties (21% are aged 41-50 years). Thus, more than half of the respondents belong to the age span of 31-50 years, which is also the period where most form family and have children.

Regarding household composition, 13% live in a one-person household, 37% in a household with two adults without children, 38% in a household with two adults and one or more children and 5% in a household with one adult and one or more children. Finally, 6% live in other kinds of multiple-person households. Thus, almost half (43%) of the respondents live in a household with children. If compared with the household composition of all Danish owner-occupied detached, terraced and farm houses, the survey sample have less one-person households (20% for Danish houses) and a slight overrepresentation of households with one adult and one or more children (3% for Danish houses), whereas the share of couples with or without children resembles the national figures (38% couples with children and 39% couples without children). All in all, the sample seems to reflect the Danish household composition in general. The underrepresentation of one-person households probably reflects that the elderly with the highest percentage of widows and widowers only rarely buy houses. (Statistics Denmark 2011b)

Table 1 shows the distribution of the sample by level of annual household income and compared with the distribution for all Danish homeowners. This shows a small underrepresentation of low-income households (up to 400,000 DKK or app. 53,000 Euro a year) and a small overrepresentation of wealthier households (above 400,000 DKK).

Annual income (household)	Number	Per cent	Danish homeowners (2009)
Up to 200,000 DKK	30	4%	9%
200.001-300.000 DKK	45	7%	12%
300.001-400.000 DKK	77	11%	12%
400.001-500.000 DKK	92	14%	11%
500.001-600.000 DKK	121	18%	11%
More than 600.000 DKK	306	46%	44%
Total	671	100%	100%

Table 1: The distribution of the survey sample by level of income and compared with the distribution for all Danish homeowners (also including owner-occupied flats) based on Statistics Denmark 2011c. Notice that the income groups used by Statistics Denmark are slightly different from those used in the survey (below 200,000, 200.000-299.999, 300.000-399.000 etc.). Respondents answering “Don’t know” (4) or “Rather not say” (66) and “missing” (2) are not included.

A comparison of the sample distribution by age of house with the distribution of the Danish dwelling stock (see table 2) shows that there is significant less homes in the sample built in the period 1981-2000, while homes built after 2000 are overrepresented. It is likely that the latter can be explained by the fact that all new-built houses have to get an EPC label as part of the authorization of the house.

House built in year	Number	Per cent	Danish dwellings (2009)
Before 1919	73	11%	17.8% (*)
1919-1945	81	13%	12.3% (*)
1946-1970	166	26%	25.6% (*)
1971-1980	109	17%	19.4% (*)
1981-1990	44	7%	12.4% (*)
1991-2000	16	3%	5.2%
After 2000	149	23%	7.3%
Total	638	100%	100.0%

Table 2: Distribution of dwellings by year of construction. Sample compared with all Danish detached, terraced and farm houses (Statistics Denmark 2011a). 105 respondents did not answer this question and are not included. (\*) Notice that Statistics Denmark operates with time periods that differ slightly from those used in the survey: Before 1920, 1920-1944, 1945-1969, 1970-1979, 1980-1990.

Table 3 compares the sample distribution by type of property with the distribution of the Danish dwelling stock and the original sample of 10,000 addresses. If compared to the dwelling stock, there seems to be some overrepresentation of detached single-family houses in the sample. However, if compared to the original sample the distribution of the respondents more or less reflects the distribution of the original sample, even though the share of farmhouses and terraced/semi-detached houses is somewhat higher in the final sample. This indicates that the survey is not critically biased in relation to type of house.

Type of property	Sample	Danish dwelling stock (2009)	Original sample
Farm houses	4%	7.8%	2%
Detached houses	76%	68.0%	81%
Terraced or semi-detached houses	19%	24.2%	17%

Table 3: Distribution by type of property. Figures for Danish dwelling stock: Statistics Denmark 2011a

With regard to how long the homeowners have stayed in their current property, 12% have lived there for less than 6 months, 24% for 6-11 months, 36% for 12-23 months and 28% for two years or more. Thus, two-third



of the homeowners have lived in their house for at least one year and only about a tenth for less than a half year.

Income	Age of house (built in year)			
	Before 1970	1971-1990	1991 or later	Total
Up to 400,000 DKK a year (N = 126)	52%	31%	17%	100%
400,001-600,000 DKK a year (N = 181)	50%	27%	23%	100%
More than 600,000 DKK a year (N = 271)	51%	18%	30%	99%

Table 4: Annual household income versus the age of house

As both age of the house and household income might be important explanatory factors for differences in the homeowners experience and use of the EPC, it is relevant to examine whether these two variables are correlated. Table 4 shows that for all income groups, the share of homeowners living in houses built before 1970 are equal (about 50%). However, with higher income more homeowners live in houses built after 1990, whereas the share of houses built in the 1970s or 1980s is decreasing with higher income. This probably reflects that it is in general the wealthier homeowners who can afford to either built a new house or buy a new-built house.

## 4.2 The homeowners' renovation practices

Doing home improvements is a very common activity. 538 respondents (72%) indicate that they have done one or more home improvements since moving in. The three most frequent kinds of improvements are general decoration like painting and plastering (58%), change of garden/outdoor space (49%) and replacing light bulbs with energy saving light bulbs (44%). Excluding replacing light bulbs, the five most frequent home improvements are not related to energy improvements (table 4). The three most frequent energy efficiency home improvements are improving glazing (25%), loft insulation (22%) and draught proofing (20%).

Improvement	All respondents (N = 743)	Age of house (built in year)		
		Before 1971 (N = 320)	1971-2000 (N = 169)	After 2000 (N = 149)
General decoration	58%	72%	72%	9%
Change the garden/outdoor space	49%	58%	56%	18%
Replace light bulbs with energy saving light bulbs	44%	59%	48%	11%
Fit a new or improved kitchen	33%	43%	36%	3%
Fit a new or improved bathroom	28%	38%	30%	5%
Fit double glazing or energy efficient glazing	25%	34%	31%	1%
Install loft insulation	22%	33%	19%	3%
Draught-proof windows and/or doors	20%	27%	24%	1%
Install new boiler/heating supply	19%	25%	19%	1%
Insulate the water/heating pipes	16%	27%	13%	0%
Change the heat controls	16%	23%	17%	1%
Improve the air tightness of the building	15%	22%	16%	1%
Install floor insulation	12%	20%	11%	0%
Install wood burning stove or fire place	12%	17%	12%	2%
Install cavity or solid wall insulation	11%	19%	7%	0%
Build an extension/conservatory	9%	10%	9%	4%
Insulate the hot water tank	5%	8%	4%	0%
Install ventilation system with heat recovery	3%	3%	4%	2%

Install renewable energy technologies	3%	4%	3%	1%
<i>Other improvements</i>	<i>17%</i>	-	-	-

Table 5: Home improvements in general (question: Have you improved your home in any of the following ways?). The three columns to the right show the home improvements by different age groups of the respondents' home (105 resp. not included due to missing information on age of their house). Also see Adjei et al. 2011: Table C2 & C8.

Table 5 also shows the frequency of home improvements by different age groups of the house. The Danish building code was tightened markedly with regard to the efficiency standard of new houses in 1972/73 and 1998/99 (Wittchen 2004). Thus, the time periods have been adjusted to these in order to make them reflect different energy standards of the Danish dwelling stock. Table 5 shows that the share of respondents having carried out a specific home improvement increases with the age of the house. This presumably reflects that newer houses do not require the same degree of home improvements as older houses.

With regard to future activities, 56% of the respondents indicate that they plan to carry out home improvements within the coming three years. Of these, most (61%) plan to do general decoration, while second most will change the garden/outdoor space (54%) and third most fit a new/improved bathroom (30%). Again, energy efficiency home improvements in general have a lower priority with fitting double glazing or energy efficient glazing (28%) and installing loft insulation (27%) as the most frequent improvements.

Half of the respondents (50%) had both completed home improvements and planned further works in the next three years. Most of these (84%) live in a house built before 1981 and only 10% of the homeowners with a house built later than 2000 belonged to this group. This indicates that doing home improvements is an ongoing activity for many homeowners, especially for those living in older houses. This is in line with results from a Danish survey from 2000 that showed that homeowners in general continued with doing home improvements also many years after they had purchased their house (Gram-Hanssen 2011). Thus, doing home improvements is a continuous activity for most homeowners and not something limited to the time at the house purchase. This to some degree challenges the underlying assumption of the energy labelling scheme that issuing the EPC at the time of purchase is particularly optimal.

Homeowners who had completed one or more home improvements were asked to rate the importance of nine reasons for carrying out these improvements on a scale from "1 = not important at all" to "5 = very important". Table 6 shows the percentage of respondents who rated each factor "very important". Comfort was very important for half of the respondents (53%), but also reducing the energy bill and making the property more energy efficient figure high on the list with 40% both. This indicates that even though comfort plays the most important role to homeowners' decisions on home improvements, also energy efficiency has a high priority. Interestingly, reducing the personal environmental impact is placed as the second lowest reason showing that the homeowners' interest in energy efficiency might predominantly be related to economical concerns and maybe also to energy efficiency as a more general ideal. Also it is seen that increasing the property value is rated very low by the homeowners.

<b>Reasons</b>	<b>Have completed home improvements (N = 538)</b>
To make my home more comfortable	53%
To reduce the energy bills for my home	40%
To make my property more energy efficient	40%
To make my home look nice	30%
To meet challenges in family circumstances	22%
To make other family members happy	18%
To reduce my environmental impact	16%
To increase the value of my property	12%
To improve my local neighbourhood	1%

Table 6: Reasons for completing improvements rated very important by homeowners.

Of the 538 homeowners who had completed home improvement(s), 414 homeowners (56% of the total sample) had done at least one energy home improvement (replacing light bulbs not included here).<sup>1</sup> With regard to the reasons for carrying out home improvements, this sub-group of homeowners do not differ much from the rest. Only “make property more energy efficient” and “reduce energy bills” are significantly higher for the sub-group (both are rated as very important by 49%) This indicates that the motivating reasons for doing energy efficient home renovations are not in general very different from the reasons for home improvements in general. Also, that 77% of the homeowners who had done any kind of home improvement also had done at least one energy efficiency improvement indicate that energy renovation is not an activity reserved for a limited group of homeowners (e.g. those most interested in the environment). Thus, energy renovation should be understood as an integrated part of Danish homeowners’ renovation practices.

The respondents were also asked to indicate how important a number of different benefits of improving the energy efficiency of their home were on a scale 1 to 5 according to their own opinion:

<b>Benefits</b>	<b>Rated very important (N = 743)</b>
Reducing running costs	59%
Making the home more comfortable	42%
Reducing CO <sub>2</sub> emissions	35%
Helping the environment	34%
Improving the property value	25%

Table 7: The importance of different benefits of improving the energy efficiency of their home.

Reducing running costs is rated highest by almost two-thirds of the homeowners. However, making the home more comfortable is still rated as a very important benefit by 42%. About one-third think that reducing CO<sub>2</sub> emissions and helping the environment are very important, while only 25% mark improvements in the property value as very important. This indicates that the homeowners in general regard energy efficiency improvements as something that they should benefit from themselves while they stay in their home (reduced running cost and improved comfort), and much less as something that is meant for a possible future sale. A

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<sup>1</sup> Energy efficiency home improvements included: Insulate hot water tank or water/heating pipes; fit double glazing or energy efficient glazing; install cavity or solid wall insulation, floor insulation or loft insulation; install new boiler/heating supply or wood burning stove/fire place; change the heat controls; draught-proof windows and/or doors or improved the air tightness of the building in general; install ventilation system with heat recovery or renewable energy technologies.

split by income group (not shown here) does not reveal any marked differences between the groups with regard to how important they rate these benefits.

The respondents were also asked to rate their level of trust in different sources of information on home improvements in general (figure 1) and on energy efficiency home improvements specifically (figure 2). Figure 1 shows that family and friends are the most trusted sources of information on home improvements in general. Interestingly, the EPC is the second most trusted source of information (55% indicating “complete trust” or “trust”). This seems a bit surprising, as the EPC had not been mentioned prior to this stage of the questionnaire. It is also worth noticing that Denmark is that of the five countries participating in the IDEAL EPBD survey with the highest level of trust in the EPC; the percentages for the other countries are 30% in the Netherlands, 34% in England, 39% in Finland and 43% in Germany (Afi et al. 2011: Table C43). This difference might relate to that the Danish energy labelling scheme has been running for a longer time or, perhaps, that Danes in general trust public authorities more than compared to other countries (see for instance European Social Survey 2008 that shows that Denmark have the highest scores of trust in politicians in Europe).

Figure 2 shows that with regard to sources of information on energy efficiency improvements, the EPC is the most trusted source of information followed by local and national authorities and family/friends. Thus, Danish homeowners in general trust official institutions like the EPC and the authorities more than informal sources like family/friends and neighbours. Again, Denmark differs from the other four countries as more Danish homeowners trust in the EPC and less in family and friends. For the total sample of the five countries (Denmark included), the order of the most trusted sources on energy efficiency is: Family and friends (51% “trust” or “complete trust”), local tradespeople (46%) and the EPC (39%) (Adjei et al. 2000: Table F7-F17).

The three least trusted sources of information are advertisements, DIY shops and the internet. The latter (internet or general web search) is at the same time the source of information that second most homeowners (52%) would consider to use to gain more information on making improvements to the energy efficiency of their home (Adjei et al. 2011: Table F19). Only the government funded body Center for Energibesparelser (Centre of Energy Savings, the former Elsparefonden) is opted by more (56%). It appears somewhat paradoxical that the internet and general web searches at the same time are the second most used source of information on energy improvements and the third least trusted source. However, this might reflect a “critical-positive” attitude with homeowners regarding the internet as a useful tool to get information at the same time as they critically evaluates the quality and reliability of the information presented on different websites. Perhaps it also reflects the diversity of the internet with many different sources differing in quality, expertise and trustworthiness.

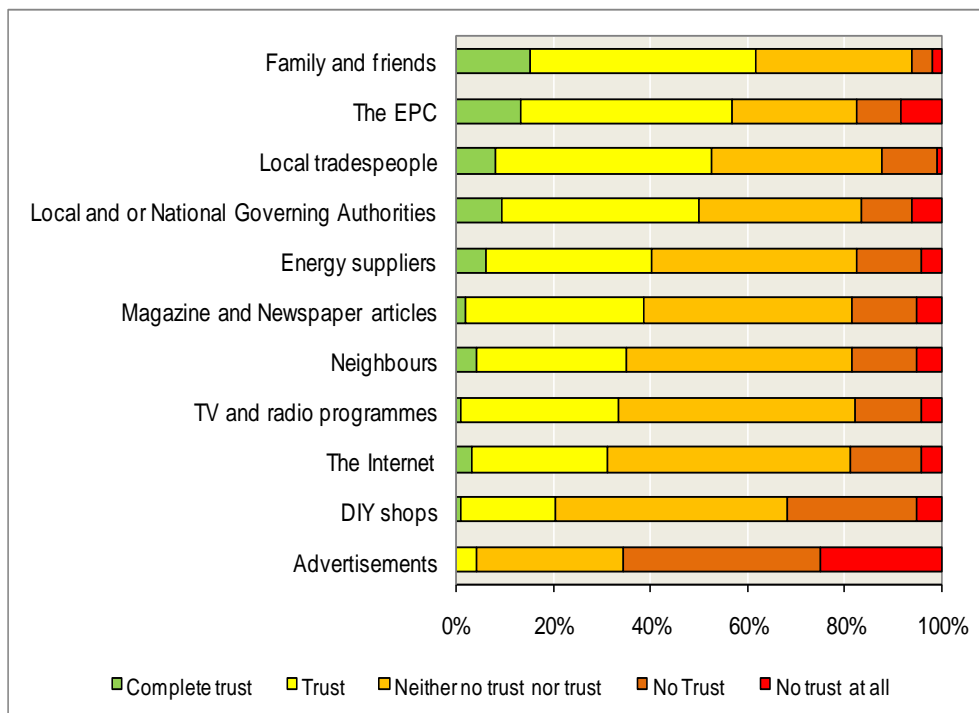


Figure 1: Homeowners' level of trust in various sources of information on home improvements in general (question: How much do you personally trust the following sources of information about home improvements and repairs?)

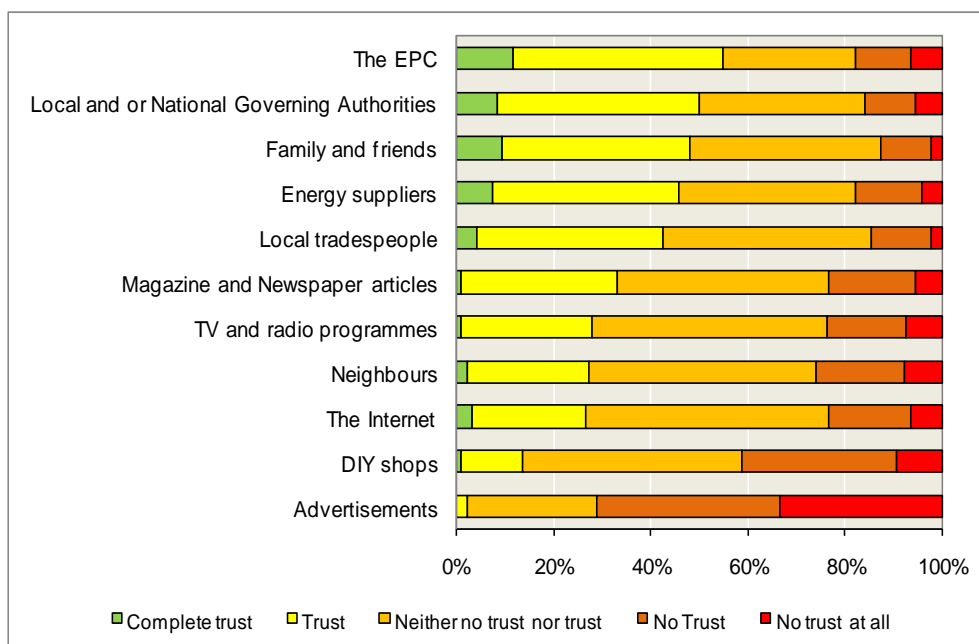


Figure 2: Homeowners' level of trust in various sources of information on energy efficiency for the home (question: How much do you personally trust the following sources for information about energy efficiency in houses?)

Summing up, the above results show home renovation to be a widespread and (for many homeowners) continuous activity, especially for houses built in the 1970s or earlier. Most homeowners rate comfort as a very important reason for carrying out home improvements, but also reducing the energy bill and making the

property more energy efficient were rated high. Family and friends are the most trusted source of information about home improvements in general, but when it comes to energy efficiency, the EPC is rated highest. The following section will present more detailed information on the homeowners use and understanding of the EPC.

#### 4.3 Homeowners' understanding and use of the EPC

The level of trust in the EPC as a source of information on energy efficiency improvements seems to partly depend on the level of household income (figure 3). Lower income groups (up to 600,000 DKK or app. 80,000 Euro a year) in general trust the EPC less than the higher income groups.

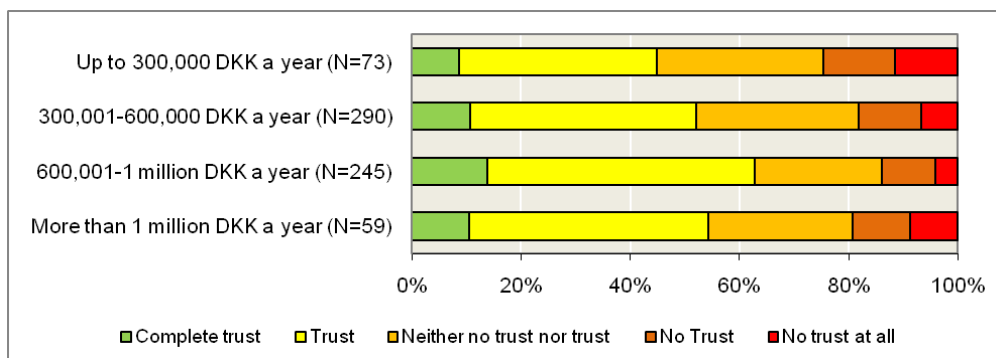


Figure 3: Trust in EPC as a source of information about energy efficiency improvements by level of household income.

The level of education seems to play a minor role as the share of homeowners answering complete trust or trust do not vary much with different levels: The percentage of trust and complete trust is 60% for respondents with primary/secondary school or upper secondary school as their highest level of education (N = 81), 48% of respondents with basic vocational training or a short-term education (N = 225) and 53% of respondents with a medium or higher level of education (N = 427).

The majority of the homeowners (90%) state that they have heard about the EPC prior to the survey (6% answer “no” and only 4% “don’t know”). Most have heard about the EPC through an estate agent or in relation to the property sales material (in both cases 54%). Second most have heard about it through the media (33% from the television, 28% in newspapers and 27% on the internet). Furthermore, 27% report that they have heard about the EPC through their energy suppliers.

79% of the homeowners (585 resp.) report that they have an energy label for their own home. This shows that even though all the homeowners participating in the survey should have had an EPC (due to the recruitment method), about one out of five has not noticed the EPC or has forgotten it again.

Of the homeowners who do remember that they have an EPC, 63% saw the EPC before making an offer, while 18% received it after the offer was accepted but before completion of the deal and 12% did not see the EPC until after the completion of the house deal. 54% indicate that they also saw the EPC for some or most of the other properties they considered to buy. Of those who saw the EPC before they made an offer for their house, 38% state that the EPC was important or very important for their decision to make an offer. However, only 11% of the homeowners with an EPC for their house used the EPC to negotiate on the price of their home. 30% think that the EPC was important or very important for their decision to buy their current house, which is somewhat lower than the 51% who state that the expected running costs for water, electricity and heating played an important or very important role for their decision to buy the house.

Most of the homeowners aware of having an EPC find it easy or very easy to understand the EPC (73%) and only 6% find it difficult or very difficult (19% find it neither difficult nor easy). Of those respondents aware of having an EPC for their home, 42% trust that the EPC provides an accurate summary of the energy efficiency of their home, while 24% do not trust this and 23% neither trust or distrust (11% don't know).

400 (68%) of the homeowners remember that they got an EPC that included recommendations for energy efficiency improvements. The three recommendations that most respondents recall are: Insulate roof and/or loft (66%), improve glazing (52%) and insulate walls (43%). Of those remembering the recommendations, 32% report that they have not spent any money on carrying out the recommendations, while 10% have spent less than 5,000 DKK (app. 650 Euro), 28% have spent 5-50,000 DKK (app. 650-6,700 Euro), 12% 50-100,000 DKK (app. 6,700-13,300 Euro) and 14% more than 100,000 DKK (4% Don't know).

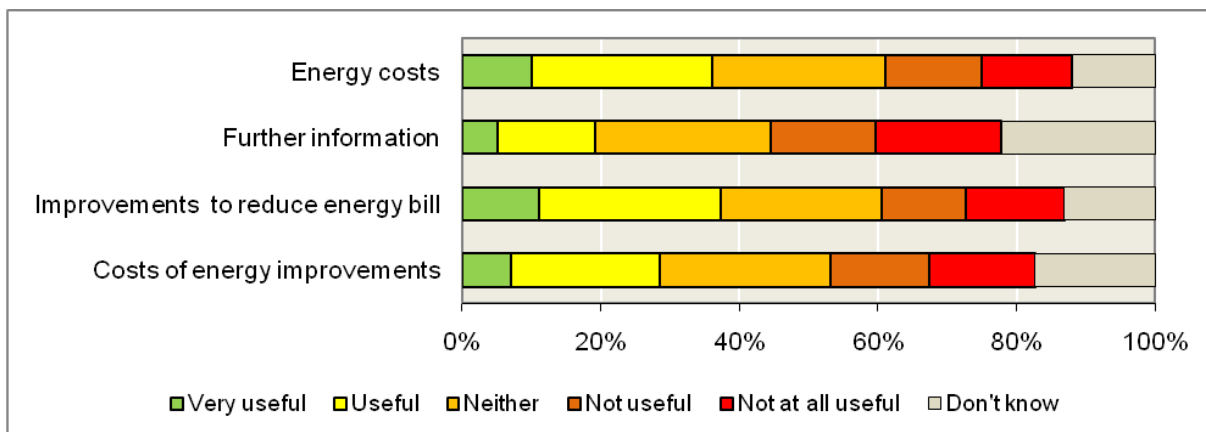


Figure 4: The homeowners' experience of the usefulness of the EPC as a source of information on the energy costs (electricity and heating) of the home, on where to find advice and further information on energy efficient measures, on home improvements needed to reduce energy bills and on the costs of making these improvements. Only respondents aware of having an EPC (N = 585).

The survey also included four questions on the perceived usefulness of the EPC (figure 4). Overall, less than 40% of the homeowners find the EPC useful or very useful. Most find the EPC useful as a source of information on improvements needed to reduce the energy bills (37%) and on energy costs of the home (36%), whereas only 19% think that the EPC is useful as a source for information on where to find advice and further information on energy efficient measures and 28% find it useful as a source on the costs of energy improvements.

It is interesting to notice that even though the EPC is the most trusted source of information on energy efficiency measures (figure 2) and almost 75% find it easy to understand and almost half (42%) trust that it provides accurate information about the energy efficiency of their house, it is only 20-40% of the homeowners that actually experience the EPC as useful. This indicates that despite having a high level of reliability, the EPC is in general not regarded as a useful tool for information by the homeowners.

The low rating of the usefulness of the EPC might be related to a general feeling among the homeowners of not lacking knowledge about the energy efficiency of their house and how to improve it; only 8% report that they experience difficulties with accessing information on how to improve the energy efficiency of their home, while 51% find it easy or very easy (23% find it neither difficult nor easy). The most important reasons for not doing energy efficiency improvements are the lack of ability to make improvements yourself and difficulties finding reliable tradespeople (in both cases 27% of the homeowners state that this would put

them off). This indicates that from a homeowner perspective, it is the practical issues like finding the right tradespeople or lack of skills rather than the lack of knowledge that keep homeowners from doing energy efficiency improvements. Also financial aspects play an important role; especially the overall costs of making improvements and whether the reduction in the energy bill is worth the time and money, but also the payback time and whether the homeowner has saved enough money (table 8).

<b>Factor/incentive</b>	<b>Rated important or very important (N = 743)</b>
The overall cost of making improvements	75%
Whether the reduction in the energy bill is worth my time and money	73%
The time it will take to get back the money invested through savings on energy bills	69%
Whether I have saved enough money to make improvements	65%
Whether I can get a grant for the type of work that will improve my property	44%
The amount of grant money available to me	41%

Table 8: The importance of monetary factors and incentives (question: How important are the following, when you are thinking about energy efficiency home improvements and repairs?)

It should be noted that the size of household income plays an important role for the importance of the financial aspects in table 8, especially with regard to overall costs and savings: For the lower income households (up to 600,000 DKK or app. 80,000 Euro a year), the overall costs are very important for 39%, while this figure is only 31% for the higher income households (more than 600,000 DKK a year). The difference are even more clear for saving enough money, as 42% of the lower income households rate this as very important compared to 30% of the higher income households. This indicates that for the lower income groups, doing energy improvements is to a high degree also a question of having enough money for the investment.

It is also interesting that from a list of different monetary and fiscal incentives, most homeowners are interested in a reduction in the price of energy efficiency products (84% report interested or very interested), while fewest are interested in a low interest loan for energy home improvements and repairs (52%). This, in combination with the importance of the overall costs and having saved enough money (table 8), indicates that Danish homeowners in general do not consider borrowing money as a way of financing energy efficiency improvements. Rather, they prefer to save up money in order to pay in cash for improvements. This is an important observation, as it seems to be an underlying assumption of the design and content of the EPC that the homeowners act as “economical rational” actors who consider payback time as the most important factor for deciding on whether to do energy efficiency improvements. The payback time is thus highlighted as a particular important information in the EPC, while from a homeowner perspective it seems more important to focus on the other financial and practical aspects like the size of investment or how to get help to do the improvements (e.g. how to find reliable tradespeople or were to get information that can help the homeowner to carry out the improvements him-/herself as “do-it-yourself”).

With regard to the influence of the EPC on the homeowners’ decisions regarding energy home improvements, the survey provides ambiguous results. On the one hand, 64% of the 400 respondents who do remember that they got an EPC with recommendations have actually completed at least one energy efficiency improvement, whereas this is only the case for 43% of the 190 respondents who state that their EPC did not include any recommendations. Thus, there seems to be a positive relation between whether homeowners remember recommendations and whether they have done energy efficiency improvements. The causality of this link is, however, open for interpretation, as it is not possible to determine whether this is actually due to a positive influence of the recommendations in the EPC or whether it just reflects that



homeowners who have carried out energy renovations are more likely to have noticed or remember the recommendations. Some results seem to support the latter interpretation, as there is no significant relation between whether respondents remember the energy efficiency rating of their house or not and having completed energy improvements (58% of the 451 who remember their energy rating have completed energy efficient improvements compared with 56% of the 142 respondents who do not recall their rating; 150 did not answer the question).

All in all, there is no strong evidence in the Danish survey results that indicates that the EPC in general has an important influence on homeowners' decisions regarding energy renovations. This observation is partly supported by a binary logistic regression analysis based on the total sample for four of the countries participating in the IDEAL EPBD study (Denmark, the Netherlands, England and Germany). The aim of the test was to determine which factors have an effect on whether the homeowners had completed one or more energy efficiency measures at the time of the survey or not. For homeowners who had purchased their dwelling between 6 and 24 months before the survey, the EPC status (i.e. to what degree the homeowners were aware of having a label and whether it included recommendations) indeed had some positive influence on whether homeowners carried out efficiency measures, but this was much lower than the influence of the condition and the age of the dwelling, which were up to 13 times that of the EPC status. (Adjei et al. 2011: 98)

## 5. Conclusions

The study of Danish homeowners experience and use of the EPC did not find any substantial evidence that indicates that the EPC in general has a significant influence on the Danish homeowners' decisions and practices related to home energy improvements. Paradoxically, the study shows that Danish homeowners on the one hand find the EPC to be both a trustworthy, accurate and accessible source of information about the energy performance of their house, but on the other hand it is only 20-40% who find it useful as a source of information on how to reduce the energy consumption. The reason for this paradox might be related to the results that show that the homeowners in general do not feel any lack of knowledge in relation to the energy efficiency of their house and how to improve it. Another possible explanation can be that the homeowners' in general experience that the information provided by the EPC have a general and trivial character, i.e. that the EPC does not provide recommendations that the homeowner would not have expected him/herself.

The results indicate that the limited impact of the Danish EPC is in general not related to a lack of reliability or problems with understanding the label and the recommendations. Rather, future improvements should focus on improving the usability of the level, e.g. by including more information on how to find further information or by taking into account that DIY is very common in relation to home improvements. For instance, the EPC could help homeowners to find further information and advice on how to carry out energy renovation as DIY.

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